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Vol. 14, No. 1

25th Anniversary
1958-1983

About the Cover

Launch of *Explorer 1* on Jan. 31, 1958, the beginning of the U.S. space program—our national answer to the Russian launch of Sputnik on Oct. 4, 1957. This first U.S. satellite sent into orbit was launched by the U.S. Army as part of the International Geophysical Year satellite programs; Secretary of the Army Wilbur M. Brucker announced the satellite's name, *Explorer 1*. The name indicated the mission of this first satellite and its NASA successors—to explore the unknown.

When NASA was formed in 1958 to conduct the U.S. civilian space program, responsibility for the International Geophysical Year satellite programs was assigned to NASA. The decision was made by the National Advisory Committee for Aeronautics (NACA), NASA's predecessor, to continue the name *"Explorer"* as a generic term for future NASA scientific satellites. Explorers were used by NASA to study the atmosphere and ionosphere; the magnetosphere and interplanetary space; astronomical and astrophysical phenomena; and the Earth's shape, magnetic field and surface.

Below is a calendar highlighting past events in NASA's history as they occurred in the month of January.

NASA's 25th Anniversary, Oct. 1, 1983

Historical Calendar for January

Date	*Event*
1/5/72	Shuttle program approved by Congress
1/5/79	Voyager 1 Jupiter flyby
1/7/68	Launch of Surveyor VII
1/7/78	Launch of Intelsat IVA F-3
1/11/67	Launch of Intelsat II F-2
1/11/68	Launch of Explorer XXXVI
1/15/70	Launch of Intelsat III F-6
1/15/76	Launch of Helios-B (2)
1/16/76	Launch of CTS
1/16/82	Launch of RCA Satcom-4
1/18/80	Launch of Fltsatcom-3
1/19/65	Launch of Gemini II
1/19/74	Launch of Skynet II-A
1/20/66	Launch of Little Joe II-A
1/21/60	Launch of Little Joe 1 B
1/21/64	Launch of Relay II
1/22/65	Launch of Tiros 9
1/22/68	Launch of Apollo 5
1/22/69	Launch of OSO-V
1/22/75	Launch of Landsat 2
1/23/70	Launch of OSCAR 5
1/23/70	Launch of ITOS-1
1/23/72	Launch of Intelsat IV F-4
1/25/64	Launch of Echo II
1/26/62	Launch of Ranger III (P-34)
1/26/67	Launch of ESSA IV
1/26/71	Launch of Intelsat IV F-2
1/27/67	AS 204 Fire
1/28/77	Launch of NATO IIIB
1/29/64	Launch of Saturn 1 (SA-5)
1/29/76	Launch of Intelsat IVA-F2
1/30/64	Launch of Ranger VI
1/30/69	Launch of ISIS-A
1/30/79	Launch of SCATHA
1/31/58	Launch of Explorer 1
1/31/61	Launch of Mercury (MR-2)
1/31/71	Launch of Apollo 14
1/31/72	Launch of HEOS A-2

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Shuttle Mission 6—Pre-launch Statistics

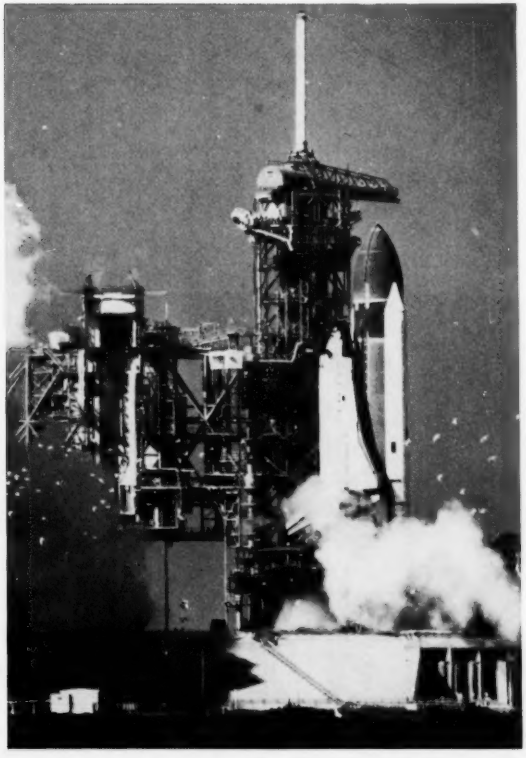
Crew . . . . . Paul J. Weitz, commander
Karol J. Bobko, pilot
Donald H. Peterson, mission specialist
Story Musgrave, mission specialist

Orbiter. . . . . Challenger (OV-099)

Launch site . . . . . Pad 39A, Kennedy Space Center, Fla.

Launch date/time . . February
9 a.m. EST

Orbit . . . . . 153 nautical miles (176 statute miles) after OMS-2 burn; 153 nm × 186 nm (213 statute miles) after TDRS deployment; will then circularize at 150 nm (172.5 statute miles)



Flight readiness firing of Space Shuttle Challenger's main engines on Dec. 18.

Orbital inclination . 28.5 degrees

Mission duration. . . 5 days
80 full orbits; deorbit burn on 81st orbit

Mission firsts . . . . . First flight of orbiter Challenger
First flight of lightweight External Tank
First flight of Inertial Upper Stage aboard the Space Shuttle

Principal cargo . . . . Tracking and Data Relay Satellite (TDRS)-A

Other experiments . Three Getaway Specials:
Artificial Snow Crystal Experiment
Seed Experiment
Air Force Academy Experiments
Monodisperse Latex Reactor
Continuous Flow Electrophoresis Experiment
Nighttime/Daytime Optical Survey of Lightning
Aerodynamic Coefficient Identification Package (modified from STS-5)

Principal mission activity . . . . . Deployment of TDRS-A approximately 10 hrs. after launch
EVA (extravehicular activity) on flight day four

Preferred landing site. . . . . Edwards Air Force Base, Calif.

Weather alternate landing site . . . . . White Sands Missile Range, New Mexico

Contingency landing sites . . . . . Dakar, Senegal
White Sands Missile Range, N. Mex.
Rota Naval Station, Spain
Hickam Air Force Base, Hawaii
Kadena Air Base, Okinawa

Abort landing sites . Return-to-Launch-Site: Kennedy Space Center, Fla.
Abort-Once-Around: White Sands
Transatlantic: Dakar, Senegal

Orbiter Differences Between Challenger and Columbia

A number of differences exist between Space Shuttle orbiters Columbia and Challenger. Most derive from the fact that Columbia is configured to serve the Shuttle program's research and development phase, while Challenger comes equipped as a basic operational spacecraft.

Columbia's control and display panels have numerous sensors and instrumentation configured for data collection and processing in the orbiter's flight test phase. Challenger's display panel has fewer of these instruments and more equipment to support operations, such as the Ku-band antenna system for tracking future data relay satellites. Challenger is equipped with a "heads-up" display system at the commander and pilot stations. This system displays essential flight control information onto transparent glass at eye level enabling the commander and pilot to reference simultaneously for approach and landing what they are viewing outside the orbiter windows with the cockpit instrumentation readings.

Columbia's cabin for the first four flights contained an elaborate ejection seat system for the commander and pilot. Ejection capability was required during the orbital flight test phase in case a catastrophe had occurred during launch or landing. Challenger has no ejection system. The space used for ejection equipment on Columbia will be used to provide seats for mission specialists on Challenger.

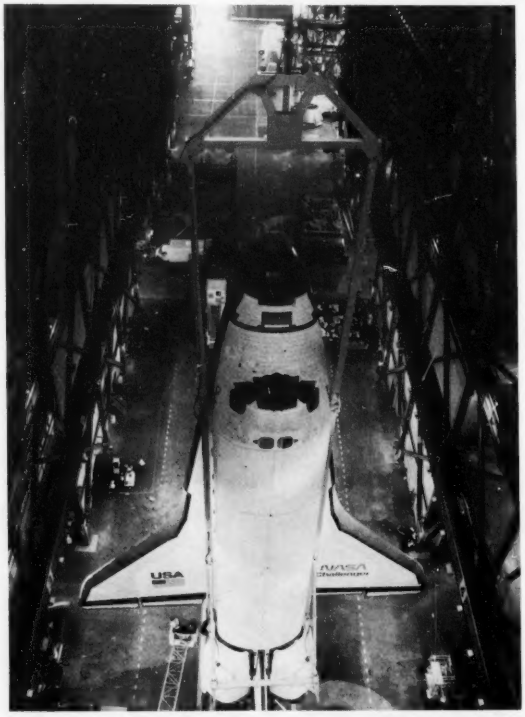
On Challenger's first flight in February, all four flight crew members will be seated in the orbiter flight deck. Challenger also will be capable of seating three additional crew members in the mid deck on later flights.

Shuttle managers have reduced the weight of Challenger from that of Columbia by about 907 kilograms (2,000 pounds). Lightening the orbiter's structure increases the spacecraft's ability to carry heavy payloads and additional crew members on operational flights. Orbiter weight of Challenger during its Nov. 23 rollover from the Orbiter Processing Facility to the Vehicle Assembly Building at Kennedy Space Center was 79,500 kg (175,265 lbs.).

Where Columbia's flight and mid-deck floors are substantial enough to support workers on the ground, Challenger's have been thinned out to such an extent that ground support personnel must stand on temporary platforms. Where Columbia's forward fuselage uses tube supporting frames, Challenger's has thin wire shelves. Where Columbia has titanium cryogenic tank support tubes in the mid fuselage, Challenger has tanks made of lighter boron aluminum. Columbia's backup structure around the main engine pump in the aft fuselage is eliminated on Challenger; and some primary and secondary support frames are combined. Challenger's landing gear doors in the wing area are redesigned with a lightweight honeycomb mesh.

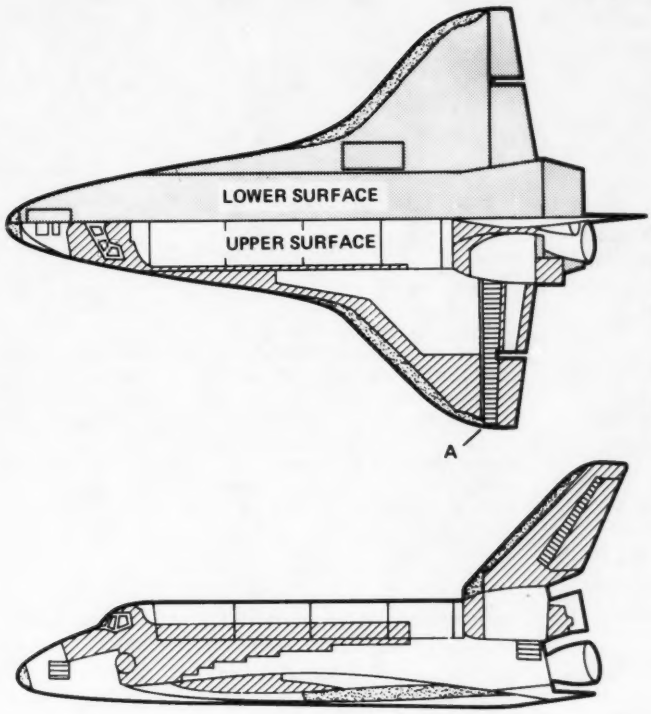
On her first three test flights, Columbia carried six potable water tanks on her mid deck floor; two of these have been removed. The removed tanks would have provided additional cooling in case the payload bay doors had not opened when the spacecraft first achieved orbit during the experimental phase. They are not necessary to operational flights; Challenger has only four tanks.

On the exterior, the two orbiters differ in their thermal protection systems. Columbia is getting her heat-shielding tiles replaced with tough, adhering densified tiles during between-mission turnarounds. Densified tiles are hardened with a slurry mixture, making them hard and slick and eliminating porosity



Orbiter Challenger suspended by a special lifting sling inside the Vehicle Assembly Building. Kennedy Space Center, as it is readied for mating with the twin solid rocket boosters and external tank in high bay 3.

THERMAL PROTECTION SYSTEM
SPACE SHUTTLE CHALLENGER, ORBITER 099


LOWER SURFACE
UPPER SURFACE
A
REINFORCED CARBON-CARBON (RCC)
HIGH TEMPERATURE, REUSABLE SURFACE INSULATION (HRSI)
LOW TEMPERATURE, REUSABLE SURFACE INSULATION (LRSI)
COATED NOMEX FELT, REUSABLE SURFACE INSULATION (FRSI)
METAL OR GLASS
A ADVANCED FLEXIBLE REUSABLE, SURFACE INSULATION (AFRSI)
WILL BE USED IN ELEVON COVE AREA OF THE WINGS THE AFRSI BLANKET WILL ALSO REPLACE SOME LRSI TILES IN THE OMS PODS AREAS

which makes undensified tiles vulnerable to loosening. All of Challenger's tiles have been densified.

Additionally, Challenger's orbital maneuvering system/reaction control system pods carry an advanced thermal protection blanket called Advanced Flexible Reusable Surface Insulation (AFRSI). It consists of a silica material sandwiched between an upper and lower quilt. The quilt is bonded directly on the orbiter's skin. It weighs less than the tiles and is easier to install, more durable and less easily damaged. AFRSI will replace the low temperature white tiles on all subsequent orbiters which equals about 606 tiles.

Challenger's vehicle identification markings also differ from Columbia's. Looking at the vehicle upright at the launch pad, the "USA" designation and the U.S. flag appear on the left wing of Challenger. The NASA logo and the vehicle name "Challenger" appear on the right wing. For Columbia, the USA marking appeared alone on the right wing and the U.S. flag alone on the left wing. The other use of the spacecraft name Challenger has been moved farther forward on the vehicle, positioned now on the side of the vehicle beneath the orbiter cockpit windows. For Columbia, the name appeared on the forward section of the payload bay doors; however with the doors open, the name was not visible. With the new placement, this identification will remain visible during on-orbit operations. Part of the modifications performed on Columbia will include changing the vehicle markings to conform to those redesigned for Challenger.

Columbia is currently undergoing a series of modifications which will lighten the spacecraft and configure her like Challenger for operational flight. Columbia's next scheduled flight is September 1983.

Nasa's Tracking and Data Relay Satellite System

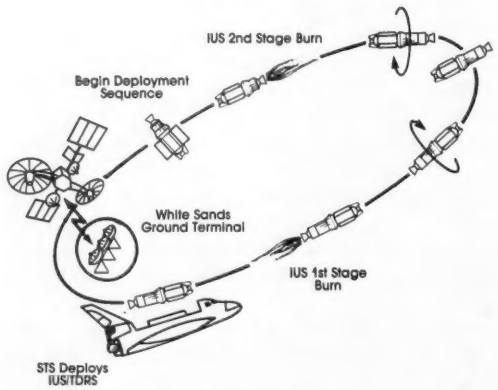
When it makes its debut in orbit on the sixth Space Shuttle flight, the first Tracking and Data Relay Satellite, TDRS-A, will inaugurate a new era in the way

Earth-orbiting spacecraft—including the Space Shuttle—are tracked and their vital data is transmitted to Earth. Instead of the existing worldwide network of ground stations which can provide coverage up to only 20 percent of the time, the Tracking and Data Relay Satellite System (TDRSS), consisting of two satellites and an in-orbit spare, will be able to provide almost full-time coverage not only for the operational Space Shuttle, but for up to 26 other Earth-orbiting spacecraft simultaneously.

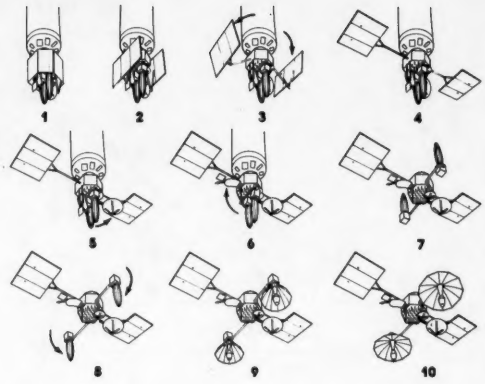
These revolutionary new tracking stations in space, launched from the Space Shuttle, will operate at geosynchronous orbit 35,890 kilometers (22,300 miles) above the Earth's equator. At that altitude, because the speed of the satellites is the same as the rotational speed of the Earth, they remain "fixed" in orbit over one location.

Distinguishing physical features of the satellites include their two huge, wing-like solar panels which provide 1,850 watts of electrical power and two 4.9-m (16-ft.) diameter high-gain parabolic antennas which resemble giant umbrellas. These antennas weigh about 18 kg (50 lb.) each. Because of the effect of the Earth's gravity, a ground-based antenna of similar size and capability would weigh about 2,250 kg (5,000 lb).

The TDRS-A spacecraft will be deployed from the orbiter Challenger approximately 10 hours after the launch from Kennedy Space Center at an altitude of about 240 kilometers (150 miles). Boost to geosynchronous altitude and apogee kick will be provided by the Air Force-developed solid propellant



NASA's Tracking and Data Relay Satellite-A deployment from Space Shuttle Challenger, Feb. 1983.



Tracking and Data Relay Satellite-A appendage deployment sequence. (1) Sequential release and deployment of the appendages begin while attached to the Inertial Upper Stage. (2) Outboard solar array panels are released. (3) The solar array booms are released and deployed. (4) The array booms are latched after deployment. (5) The space-to-ground-link antenna is released and deployed. (6) The C-band antenna is released and deployed. (7) The single access antenna booms are deployed. (8) The single access antennas are rotated into position. (9) The single access antennas are deployed. (10) The final orbital configuration is attained.

two-stage Inertial Upper Stage (IUS) built by the Boeing Aerospace Co., Seattle. Separation from the IUS occurs approximately 17 hours after launch. Repeated Earth pointing for TDRS commands and telemetry, plus thermal control maneuvers, will take place by the IUS between first and second stage burns.

Deployment of the solar panels, C-band antenna and space ground link antenna occur prior to TDRS separation from the IUS. The single access parabolic antennas deploy after separation and subsequent to acquisition of the Sun and Earth by spacecraft sensors utilized for attitude control. Attitude and velocity adjustments place the TDRS into its final geosynchronous position. The TDRS spacecraft is three-axis stabilized with the body fixed antennas pointing constantly at the Earth while the solar arrays track the Sun.

The operational TDRSS satellites will be positioned over the equator about 130 degrees apart. TDRS-A, or TDRS East, will hover over the northeast corner of Brazil at 41 degrees west longitude. The other satellite, TDRS West, scheduled for launch aboard the Space Shuttle in July 1983, will be positioned southwest of Hawaii at 171 degrees west longitude. The in-orbit spare will be centrally located and available for use in the event one of the operational satellites malfunctions, or to augment system capabilities during peak periods.

Launch of this in-orbit spare is scheduled for March 1984.

The data acquired by the two-satellite system will be relayed to a single centrally located ground terminal at NASA's White Sands Test Facility, N. Mex. From there, the raw data will be sent directly by domestic communications satellite to NASA control centers at Johnson Space Center, Houston, for Space Shuttle operations and to the Goddard Space Flight Center, Greenbelt, Md., the center which schedules TDRSS operations and controls a large number of unmanned satellites.

Like the TDRSS satellites, the White Sands Ground Terminal is one of the most advanced facilities of its kind. Its most prominent features are three 18 m (59 ft.) Ku-band antennas used to receive and transmit user traffic. Several other smaller antennas are used for S-band and Ku-band communications.

When the NASA Tracking and Data Relay Satellite System is fully operational in early 1983 (including the in-orbit spare), ground stations of the worldwide Spaceflight Tracking and Data Network (STDN) will be closed or consolidated resulting in savings in personnel and operating and maintenance costs. Moreover, much of the equipment at the ground stations is almost 20 years old and would have required replacement to meet the demands of the Space Shuttle and today's advanced spacecraft.

The satellites that make up TDRSS are the largest and most advanced communications satellites developed thus far. They weigh almost 2,250 kilograms (5,000 pounds) and measure 17 meters (57 feet) across at the solar panels. Operating in the S-band (2.2-2.3 gigahertz) and Ku-band (13.7-15.2 gigahertz) frequencies, their complex electronic relay systems can handle up to 300 million bits of information each second from a single user spacecraft.

The TDRSS operational system can provide continuous global coverage of Earth-orbiting spacecraft above 1,200 km (750 mi.) up to an altitude of about 5,000 km (3,100 mi.). At lower altitudes there will be brief periods when satellites over the Indian Ocean near the equator will be out of view.

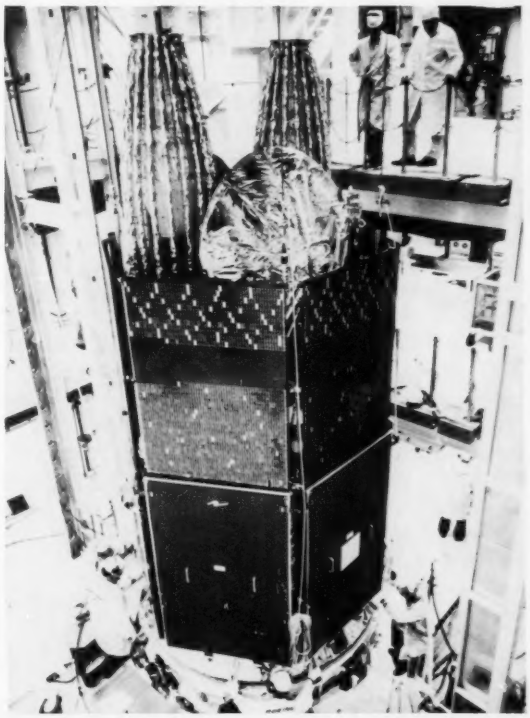
Deep space probes and Earth-orbiting Spacecraft above about 5,000 km (3,100 mi.) will use the three ground stations of the Deep Space Network (DSN) operated for NASA by the Jet Propulsion Laboratory, Pasadena, Calif. The Spaceflight Tracking and Data Network stations that were co-located with the three Deep Space Network stations—Goldstone, Calif.; Madrid, Spain; and Canberra, Australia—will be consolidated with the Deep Space Network.

The TDRSS communications capability extends across a wide spectrum that includes voice, television, analog and digital signals. In order to increase system reliability and availability there will be no signal processing done onboard the satellites. Instead, the raw data literally will flow through them at extremely high rates directly to the ground terminal. During Space Shuttle missions, mission data and commands will pass almost continuously back and forth between the orbiter and the Mission Control Center at the Johnson Space Center.

NASA is developing a sophisticated operational control system to schedule the use of the system. These control facilities, located at Goddard Space Flight Center and adjacent to the ground terminal at White Sands, will enable NASA to schedule the TDRSS support of each user and to distribute the user's data directly from White Sands to the user.

Initially, the TDRSS will be used to support the Space Shuttle, Spacelab and the Landsat-D Earth resources satellite program.

The TDRSS system is owned and operated by the Space Communications Co. (SPACECOM),



NASA's Tracking Data and Relay Satellite is mated to the Interim Upper Stage.

Gaithersburg, Md., a partnership affiliated with Continental Telecom, Inc., Fairchild Industries, Inc., and Western Union Corp.

Tracking and Data Relay Satellites are built by the TRW Defense and Space Systems Group, Redondo Beach, Calif. TRW also provides computers and software for the White Sands ground terminal. The satellite's parabolic antennas are built by the Harris Corp.'s Government Communications Systems Division, Melbourne, Fla. Harris also provides ground antennas, radio frequency equipment and other ground terminal equipment.

NASA will lease TDRSS services from SPACECOM, for a 10-year period, under a contract awarded in December 1976. Funding for the program was arranged by NASA through the Federal Financing Bank, Washington, D.C. Cost to NASA for the 10-year lease period will be approximately $250 million per year.

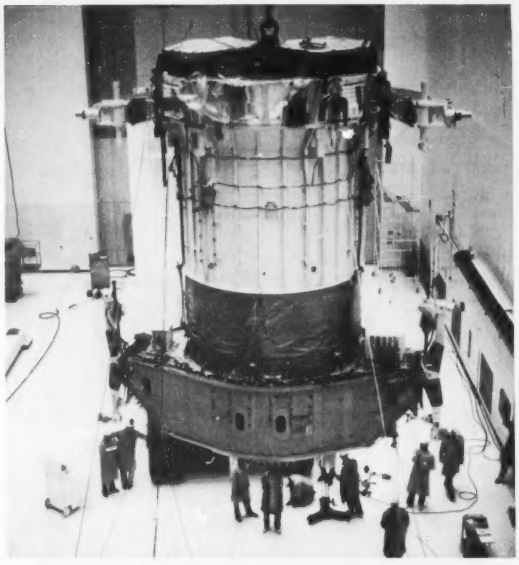
Challenger's First Flight to Carry Inertial Upper Stage

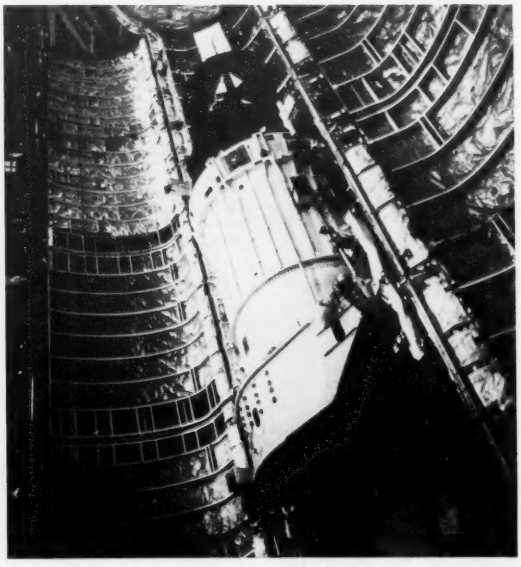
Shuttle flight six in February 1983 will be the first Space Shuttle flight to carry an Inertial Upper Stage (IUS). The upper stage is an unmanned transportation system designed to ferry payloads of up to 2,250 kilograms (5,000 pounds) from low-Earth orbit to higher orbits unattainable by the Shuttle.

For the February mission, the upper stage will be mated to a satellite called TDRS-A, the first of three which will comprise NASA's Tracking and Data Relay Satellite System. The TDRS-A/IUS-1 combined unit will be placed in the Shuttle payload bay. Once the Shuttle has reached its normal orbit of approximately 150 nautical miles (173 statute miles) above the surface of the Earth, the mated TDRS-A/IUS-1 combination will be released from the payload bay using a spring-type ejection system. The upper stage will then be ignited and will transport the satellite to geosynchronous orbit 35,890 kilometers (22,300 miles) above the Earth's equator.

A two-stage vehicle, IUS-1 is 5 meters (17 feet) in length, over 2.7 m (9 ft.) in diameter, and weighs approximately 14,742 kilograms (32,500 lbs.). It consists of an aft skirt; an aft stage that contains 9,707 kg (21,400 lbs.) of solid fuel propellant and generates 45,600 pounds of thrust; an interstage; a forward stage that contains 2,722 kg (6,000 lbs.) of solid fuel propellant and generates 18,500 pounds of thrust; and an airborne equipment support section that weighs approximately 3,329 kg (7,340 lbs.).

The equipment support section contains the avionics which provide guidance, navigation, telemetry, command and data management, reaction control and



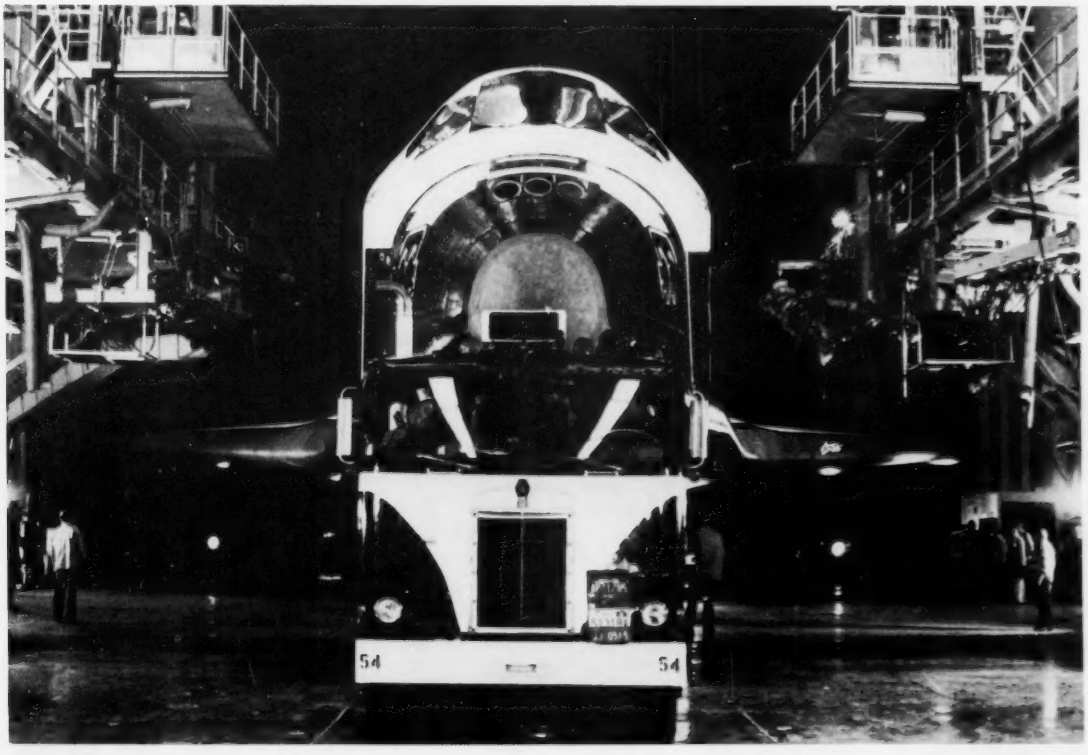


Inertial Upper Stage (IUS) undergoes checkout at Kennedy Space Center's Vertical Processing Facility (top photo). This 14,742 kilogram (32,500 lb.) rocket will boost the Tracking and Data Relay Satellite-A into geosynchronous orbit on the sixth Space Shuttle mission in February. In bottom photo, the IUS is placed in the cargo bay of Challenger for a "fit test."

electrical power. Solid rocket motors were selected in the design of the Inertial Upper Stage because of their compactness, simplicity, inherent safety, demonstrated reliability and lower recurring cost.

On the sixth Shuttle mission, the crew will begin deploying the IUS-1 approximately 10 hours after the Shuttle reaches low Earth orbit. There the astronauts will use the IUS airborne support equipment located in the Shuttle cargo bay with the upper stage, to position the IUS—with attached Tracking and Data Relay Satellite—for deployment. After final checkout, the upper stage will be released from the cargo bay by spring-like mechanisms. The orbiter will then maneuver away from the IUS until the spacecraft is a safe distance from the upper stage—approximately 35 miles. Fifty-five minutes after deployment, the aft stage of the IUS will ignite after a command from the astronauts. After a burn of two minutes, 33 seconds, the aft stage will shut down and the two stages will separate. After coasting for several hours, making "data dumps" whenever it passes over Earth tracking stations, the forward stage will then ignite six hours, 12 minutes after deployment for the final push to higher orbit. After a burn of one minute, 44 seconds, the forward stage will shut down and reach its predetermined geosynchronous orbit position. There, 6 hours, 54 minutes after deployment, the forward stage will separate from the satellite and perform an anti-collision maneuver with a reaction control system similar to that used by the Space Shuttle orbiter. As the upper stage reaches a safe distance from the payload, it will perform a final "data dump" to NASA tracking stations and will shut itself down permanently, 7 hours, 5 minutes after its release from the Shuttle cargo bay.

A number of advanced features distinguish the Inertial Upper Stage. It has the first completely redundant avionics system ever developed for an unmanned vehicle. This system has the capability to correct in-flight failures within milliseconds. The IUS also has a triply redundant inertial measurement unit, a



Not Your Ordinary Tow—Space Shuttle Challenger leaves the Rockwell Facility in Palmdale, Calif., July 3 to travel over land to NASA's Dryden Flight Research Facility, Edwards, Calif.

navigational and attitude-control device that contains five gyroscopes and provides two backup systems that come on-line in the event of failure. Other advanced features include a carbon composite nozzle throat that makes possible the high-temperature, long-duration firing of the IUS motors and a redundant computer system, in which the second computer is capable of taking over functions within milliseconds of a problem developing in the primary unit. The second computer also has the ability to diagnose the first computer's problem and decide whether it is still functional enough to serve as a new backup. The predicted reliability of IUS-1 and its successors is 98 percent.

Boeing Aerospace Co., Seattle, is the primary vehicle integration contractor. Subcontractor for the solid rocket motors is Chemical Systems Division of United Technologies Corp., Sunnyvale, Calif. Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif., is manufacturing the stage-separation device, and TRW Inc., Redondo Beach, Calif., is providing software design and telemetry, tracking and command systems hardware. Hamilton Standard Division of United Technologies Corp., Farmington, Conn., is furnishing guidance system hardware support. Delco Electronics Division of General Motors Corp., Santa Barbara, Calif., under subcontract to Hamilton, provides the avionics computer, and Ball Aerospace Systems Div. Ball Aerospace Corp., Boulder, Colo., furnishes the star scanner, a part of the guidance and navigation subsystem.

An Air Force Inertial Upper Stage similar to IUS-1 was launched in September 1982 aboard a U.S. Air Force Titan 34D expendable launch vehicle. The second Shuttle flight of an Inertial Upper Stage is scheduled for July 1983 on Shuttle mission 8 when another Tracking and Data Relay Satellite will be placed in geosynchronous orbit.

Shuttle Mission 6 To Fly Three Getaway Specials

Challenger's first mission in February will carry three Getaway Special experiments: one designed to create artificial snow crystals in the weightlessness of space, one to test the effects of spaceflight on the packaging of seeds, and one which involves six separate experiments developed by U.S. Air Force Academy cadets.

Getaway Specials, officially titled "Small Self-Contained Payloads," is a program offered by NASA to provide an opportunity to anyone who wishes to fly a scientific or technological project aboard the Space Shuttle. The canisters come in three sizes with the flight fees varying per size: 5 cubic feet, maximum weight of 200 pounds; 2½ cubic feet, up to 100 lbs., and 2 ½ cubic feet, up to 60 lbs. Prices are $10,000, $5,000 and $3,000, respectively. There are no stringent requirements to qualify for space flight but the payload must meet certain safety criteria.

Getaway Specials are flown on Shuttle missions on a space available basis. Since the offer for Shuttle space was first made in 1976, 359 reservations have been made by more than 284 individuals and groups from 30 states and the District of Columbia; 75 of these reservations are from 13 foreign nations.

Artificial Snow Crystal Experiment

This 5-cubic-foot Getaway Special is sponsored by the Asahi Shimbun newspaper, Tokoyo, Japan. The Asahi Shimbun, one of the largest newpapers in Japan with circulation of 8 million, selected the snow crystal experiment from among 17,000 ideas solicited from its readers, according to Shigeru Kimura, manager of the Analysis and Research Center for the newspaper and manager for the payload. The idea to make artificial snowflakes in the weightlessness of space was proposed by two Japanese high school students, Haruhiko Oda and Toshio Ogawa (both boys).

The Asahi Shimbun selected the snow crystal experiment because the world's first artificial snow crystal was made and investigated by a Japanese physicist, the late Ikichiro Nakaya, in 1936, according to Kimura. This time, he explained, the Asahi Shimbun hopes their sponsored Getaway Special experiment will create the world's first snow crystals in space.

The payload was designed and manufactured by Nippon Electric Co. which is the leading satellite maker in Japan. Nippon Electric has 15 out of 23 Japanese satellites, Kimura reports.

The heart of the payload is two identical small copper boxes 4 cm × 4 cm × 10 cm (1.5 in. × 1.5 in. × 3.9 in.). Two semiconductor cooling modules are attached to each box to cool down the inside of the boxes to 15 degrees Centigrade (59 degrees Fahrenheit). On the end of the box, there is a small water container made of porous sintered metal in which 20 grams (.7 of an ounce) of water is stored.

In the near zero weightlessness of orbit, the water in the container will be heated by a simple electrical heater up to 20-30 degrees C (68-86 degrees F) to generate water vapor which will be supplied continuously into the cooled box. Then, a very small platinum heater, on which a few milligrams of silver iodine is attached, will be heated up. The silver iodine will sublimate (pass

from a vapor state to a solid state without passing through the intermediate liquid state). Small particles of the silver iodine will serve as seeds of nuclei for artificial snow crystals.

Scientists have speculated that very symmetrical snow crystals could be formed in weightlessness or that some spherical crystals may be formed.

The snow crystals formed in space will be recorded on videotape with four television cameras and four video tape recorders. The lenses of the television cameras will magnify the images of the crystals.

The experiment is expected to contribute to crystallography, especially the crystal growth of semiconductors or other materials from a vapor source.

Seed Experiment

The George W. Park Seed Co., Greenwood, S. Car., is sponsoring a 2½-cubic-foot Getaway Special. The company will send 25 pounds of common fruit and vegetable seeds of roughly 40 varieties—from potatoes to sweet corn—into orbit aboard Challenger. This experiment will test the effects of space flight on the packaging of seeds and will provide the company with some ground rules for the future transport of seeds into space. "Looking to the next century, manned space stations will have to grow their own food from seeds in special enclosed environments," explained George Park, Jr., assistant vice president. "First we need to learn how the seeds have to be packaged to withstand space flight and the temperature extremes of space," he said. Researchers with the seed company, which was founded after the Civil War and now sells 3,000 varieties of seeds, plan to study the effects of extreme temperature change and radiation on the seeds. "In some instances, extra doses of radiation may be beneficial to farmers who welcome a greater probability of seed mutations," Park explained. With mutations come a genetic diversity that might mean hardier breeds of plants. On the other hand, extreme fluctuations in temperature might take their toll.

Some of the seeds are packaged in simple Dacron bags and others are sealed airtight in plastic pouches. One seed batch will be packed along the perimeter of the metal Getaway Special canister that houses the experiment, leaving it exposed to severe temperatures and cosmic radiation. Another batch of seeds will be sealed in the center of the canister where there is greater shielding from the space environment.

While nothing will be grown in the seed experiment, seeds will be germinated once they are returned to Earth. Two other identical groups of seeds left on the ground also will be studied for comparison.

Air Force Academy Experiments

This 5-cubic-foot Getaway Special is comprised of six experiments developed by U.S. Air Force Academy cadets in an engineering design course over the past 5 years. Four of the experiments will be controlled by an internal power sequencer, while the other two, powered by batteries, will be turned on separately. Five of the six experiments deal with properties of metal; the sixth experiment examines microbiological effects.

Shuttle Mission 6 Crew and Emblem—Crew members for the sixth Space Shuttle mission are (clockwise, top left to right): Paul J. Weitz, commander; Karol Bobko, pilot; Donald H. Peterson, mission specialist; and Story Musgrave, mission specialist. Crew emblem for this flight highlights the deployment of NASA's Tracking and Data Relay Satellite-A. Six stars symbolizing this mission number are at top of the emblem.

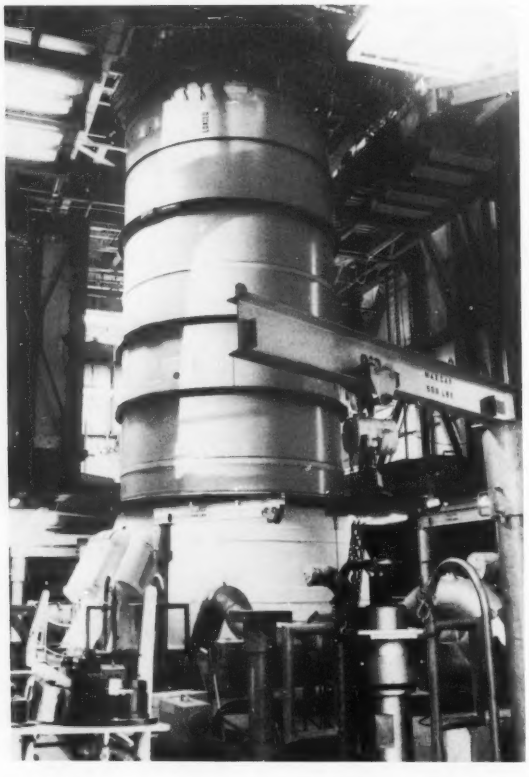
Experiment integration and spaceflight preparation is the responsibility of John E. Hatelid, assistant professor of astronautics, and six cadets. The experiments, and their objectives are as follows:

Metal Beam Joiner—To demonstrate that soldering of beams can be accomplished in space; principal investigator, Cadet First Class Harry N. Gross. (internal power sequencer)

Metal Alloy—To determine if tin and lead will combine more uniformly in a zero-gravity environment; principal investigator, Cadet First Class Mark Amidon. (internal power sequencer)

Foam Metal—To foam metal in zero-gravity forming a metallic sponge; principal investigator, Cadet First Class Richard R. Neel, II. (internal power sequencer)

Metal Purification—To test the effectiveness of the zone-refining methods of purification in a zero-gravity environment; principal investigator, Cadet First Class Joseph M. Streb. (internal power sequencer)



Booster Stacking—Solid rocket boosters to be used on the sixth Shuttle launch are stacked on mobile launch platform 2 in high bay 3 of Kennedy Space Center's Vehicle Assembly Building.

Electroplating—To determine how evenly a copper rod can be plated in a zero-gravity environment; principal investigator, Cadet First Class Lawrence J. Peter. (battery power)

Micro-Biology—To test the effects of weightlessness and space radiation on micro-organism development; principal investigator, Cadet First Class Kenneth R. Shriner. (battery power)

At a designated time in the flight, an astronaut will turn on two switches to start the electronically-sequenced experiments. Upon return from orbit, the experiment samples will be compared to base-line samples produced on Earth. Colonel Karol J. Bobko, the first Air Force Academy graduate (class of 1959) to pilot a Space Shuttle is expected to throw the switch starting the cadets' experiments.

The Getaway Special Program is managed by NASA's Goddard Space Flight Center, Greenbelt, Md. Project Manager is James S. Barrowman. Clarke Prouty, also of Goddard, is technical liaison officer. Program manager at NASA Headquarters, Washington, D.C., is Donna S. Miller.

NASA Team Reports on Space Suit Failure

A NASA team investigating the failure of two space suits during an attempted space walk on the fifth Space Shuttle flight has issued an interim report blaming two missing locking devices and a faulty motor sensor. The team is headed by Richard A. Colonna, manager of the Johnson Space Center's Program Operations Office. The space suits and related life support equipment are furnished by Hamilton Standard, Hartford, Conn.

During the mission on board Columbia, an oxygen regulator in Astronaut William B. Lenoir's suit failed to provide required suit pressure. The fan motor in Astronaut Joseph P. Allen's space suit and portable life support system refused to function.

Colonna reported that two vital plastic parts about the size of a match stick had been left out of the regulator during assembly last August by the vendor, Carlton Controls Inc., East Aurora, N.Y. Documentation indicated the parts had been installed. But technicians failed to learn of the missing parts during repeated tests, Colonna said.

The inquiry team blamed the fan failure on a faulty magnetic sensor. Cause has not yet been determined, although examination points toward moisture as a cause of this problem. The team will continue its investigation on this problem and recommends more frequent and intense testing and quality control during space suit

production and testing at Hamilton Standard, Houston and Kennedy Space Center, Colonna said.

These same suits will be used to perform the mission 6 spacewalk in February with new regulators and a new magnetic sensor installed. More thorough pre-flight testing will be instituted to ensure the operability of these suits before pre-launch stowage.

Spacewalk Added to Shuttle Flight 6

Shuttle mission 6, originally scheduled for three days, has been extended to five days to include 3½ hours of extravehicular activity (EVA). The planned EVA set for flight 5 in November 1982 was scrubbed due to separate mechanical problems with each of the two extravehicular mobility units or "spacewalk" suits. Causes of these mechanical failures have been determined by an inquiry board at NASA's Johnson Space Center. The problems with these suits have been resolved and pre-launch testing will be completed so that these same suits will be used to perform the flight 6 EVA.

The scheduled activities of the flight 6 EVA will basically follow those developed for flight 5; several new tasks have been added for this mission and flight 5's "Task Simulator Device" exercise has been dropped for this flight. The major EVA activities for flight 6 and the time required for each task are:

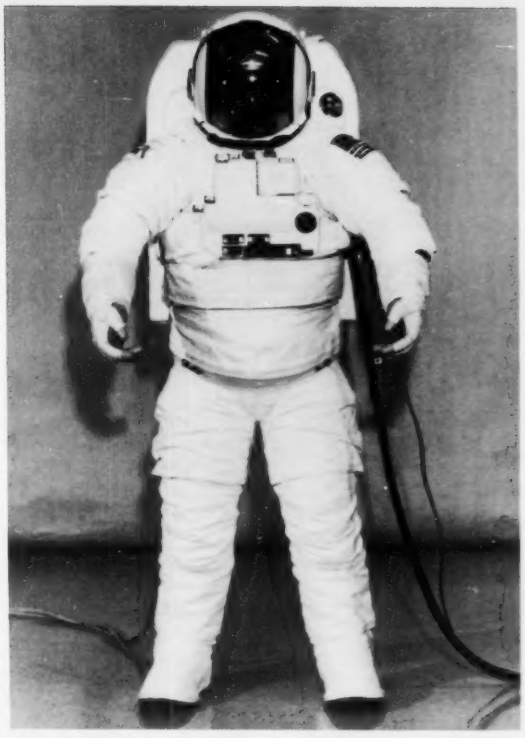
- airlock egress/ingress ..... 25 minutes
- translation operations ..... 50 minutes
- tool box operations ..... 15 minutes
- foot restraint operations ..... integrated into other activities
- extravehicular mobility unit ..... 30 minutes
- internal upper stage ..... 40 minutes
- winch operations ..... 10 minutes
- large mass transfer ..... 20 minutes
- payload retention device ..... 20 minutes

total time ..... 3½ hours

A brief explanation of the major EVA activities on flight 6 are:

Translation to Aft Bulkhead—(previously scheduled for flight 5)

translation rates (movement up and back the length of payload bay)
translation aids (tethers, slidewires, handholds)
extravehicular mobility communication/television
lighting (payload bay, lights, EMU lights, Earth/Sun lighting)
worksite evaluation (door drive linkages, power drive unit disconnect of inertial upper stage)



Space Shuttle Extravehicular Mobility Unit or spacewalk suit.

Tool box operations—(previously scheduled for flight 5)

tool tethering
tool removal/restowage
tool caddy interface with mobile work station
visibility/lighting
door/latch operations
restraint (handrails, mobile work station, foot restraint)

Foot restraint operations—(previously scheduled for flight 5)

tool box restraint
reach envelope
egress/ingress
assisted egress/ingress
portable foot restraint set up

Extravehicular Mobility Unit operability/suitability evaluation—(new activity)

zero gravity EMU fit change evaluation
joint and bearing evaluation
reach envelope determination
glove thermal evaluation
zero gravity suit pressure points determination

Inertial Upper Stage Restow Evaluation—(new activity)
- winch set up
- snatch block operations
- slip ring disconnect
- tilt table stowage

Winch operations—(previously scheduled for flight 5)
- demonstrate capability to apply loads with the winch with and without restraints
- verify precedures for door closing/IUS stowage tasks
- evaluate winch rope management in zero-gravity

Large mass transfer—(previously scheduled for flight 5)
- evaluate techniques for translating large objects using centerline latch tool bag

Payload retention device—(new activity)
- verify zero-gravity operation
- demonstrate loading capability
- evaluate zero-gravity strap dynamics

The first lightweight external tank is rolled out of the Martin Marietta manufacturing plant at Marshall's Michoud Assembly Facility in New Orleans. Shuttle flight 6 in February will be the first launch to use the new tank.

First Lightweight External Tank to Fly on Sixth Shuttle Launch

NASA's February launch of the new orbiter Challenger will also mark the first use of a lightweight external fuel tank. The new lightweight tank weighs about 32,206 kilograms (71,000 pounds), about 3,175 kg (7,000 lbs.) lighter than the tank used for the Shuttle's maiden flight in April 1981.

According to James Odom, manager of the external tank project office at NASA's Marshall Space Flight Center, Huntsville, Ala., the weight reduction was accomplished by eliminating portions of stringers (structural stiffeners running the length of the hydrogen tank), using fewer stiffener rings and by modifying major frames in the hydrogen tank. Also, large portions of the tank were milled differently to reduce thickness and weight. The weight of the tank's aft solid rocket booster attachments was reduced by using a stronger, yet lighter and less expensive titanium alloy.

"Several hundred pounds was also eliminated by deleting an anti-geyser line," said Odom. This line acted as a built-in refrigeration system, keeping liquid oxygen at its super-cold temperature while filling the oxygen tank prior to launch. NASA officials decided to remove the line after assessing propellant loading data from ground tests and the first few Shuttle missions. This line was first removed for the fifth Shuttle launch last November.

Although most of the tank's alternations will not be apparent to the casual observer, one change is already obvious: 272 kg (600 lbs.) of white latex paint was eliminated from the tank's surface before the third Shuttle flight. After analyzing data from the first mission, NASA officials determined that the external tank's thermal protection system would adequately protect the tank without the paint.

The reason for the weight reduction is to provide the Shuttle with extra payload-carrying capability. For every pound the tank's weight is reduced, the Shuttle can carry nearly one additional pound of cargo into space.

The external tanks are manufactured for NASA by Martin Marietta Aerospace, Michoud Division, New Orleans, under contract to the Marshall Space Flight Center. The first lightweight external tank was rolled out of the manufacturing plant on Sept. 10, 1982.

Shuttle Phone Service Continues for Mission 6

For Shuttle Mission 6, scheduled for launch in February, NASA and American Telephone and Telegraph Co. will again offer a "Shuttle phone service." Special telephone numbers have been established to allow news media and the general public around the world to listen in, for a charge, to air-to-ground conversations between the Space Shuttle and ground control at NASA's Johnson Space Center, Houston.

The number to call from U.S. phones is 900-410-6272.

From participating overseas locations (excluding the Caribbean, Canada and Mexico), callers should dial their country's international access code + 1 + 307-410-6272.

For the last Space Shuttle mission in November, interest in this telephone service remained high: 760,892 domestic calls and 332,386 international calls were placed: a total of 1,093,278 calls which averaged 3 minutes holding time per call.

The service will begin one hour before launch time and will continue throughout the Shuttle's flight. Launch for the January flight is scheduled for 9 a.m. EST.

Each domestic call—from anywhere in the contiguous United States, and Hawaii and Alaska—will cost 50 cents for the first minute and 35 cents for each additional minute. Overseas calls will be billed at the rates in effect in the countries where the calls originate.

All calls to the 900 number must be dialed by the callers. Coin-telephone calls, calls from hotels and motels and operator-assisted calls cannot be made to 900 numbers. Calls from overseas points, however, may be placed through an operator.

Callers will be charged for each minute they stay on the line. At some periods, when gaps occur in conversations between the Shuttle and ground control, a status report on the Shuttle mission or flight controller change-of-shift briefings may be substituted. Currently, the National Space Institute is negotiating with NASA and AT&T to manage the service.

NASA and AT&T first offered this service during the Space Shuttle's second flight in November 1981 in an effort to provide wider access to NASA's flight information line. The continued heavy response to this service has prompted NASA and AT&T to continue with this service.

NASA Studies Use of Atmosphere as a Spacecraft Brake

The atmosphere as a natural brake for NASA future upper stages is the subject of a new set of studies at Marshall Space Flight Center, Huntsville, Ala. Recently, Marshall selected two aerospace firms, Boeing Aerospace Co., Seattle, and General Electric Reentry Systems, Philadelphia, for negotiations leading to contracts for definition of a system that would use the atmosphere as a brake for orbit transfer vehicles. The contracts, valued at approximately $200,000 each, will assess future technology requirements for use of the transfer vehicles, also known as upper stages.

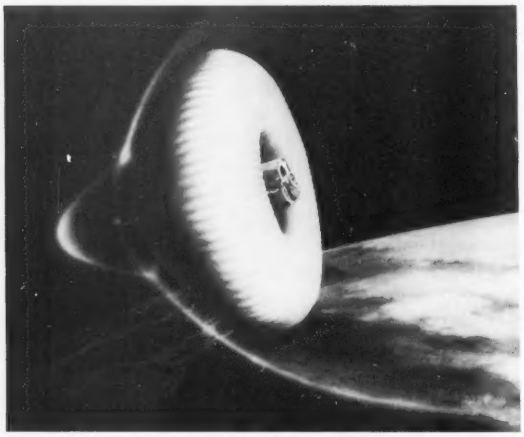
The transfer vehicle would be initially carried into space in the Shuttle's payload bay. It would later boost a payload from low-Earth orbit to one that is higher and retrieve a payload from high orbit and return it to the Shuttle. The transfer vehicle would then return to Earth in the Shuttle's payload bay.

The NASA study will examine aeroassist technology which uses atmosphere as a braking force on the transfer vehicle. Marshall Center engineers have considered for some time this fuel-saving approach to the transfer vehicle in which the spacecraft, in returning from a high-orbit drop-off or retrieval mission, would pass through the Earth's upper atmosphere before swinging out into its parking space in low-Earth orbit. When the transfer vehicle passes through the atmosphere, friction of the air against the vehicle should provide enough drag to slow the vehicle down. Otherwise, a rocket engine firing, or burn, would be required to brake the vehicle. NASA hopes to first use an aerospace transfer vehicle in the next decade.

"We think the vehicle would carry about 40,000 to 60,000 pounds of fuel," said study manager Gene Austin, "and by saving ourselves one burn we can use the extra fuel to transfer a larger amount of payload to a high orbit. We expect, in fact, about a two- to five-fold increase in payload capability."

The study is divided into three areas. Both Boeing and General Electric will be asked first to assess the state of technologies in the aeroassist area; second, to identify those critical aeroassist technologies within the entire state-of-the-art that would most likely produce a high payoff in cost, performance and/or operational simplicity in the 1990s; and third to form a technology development plan to achieve those critical technology payoffs by the 1990s.

The contract for which Boeing was selected for negotiation will deal with low lifting body designs—designs with a relatively low capability of lift to enable them to fly, but which have less weight. Goodyear Aerospace Corp., Akron, Ohio, will be a Boeing subcontractor to study flexible heat shield materials, and Grumman Aerospace Co.,Bethpage, N.Y., will be a General Electric subcontractor to study propulsion system integration.



Artist concept of aeroassist orbit transfer vehicle slowing itself with a balloon-like drag device while passing through the Earth's atmosphere before swinging out into its "parking space" in low-Earth orbit. When the transfer vehicle passes through the atmosphere the friction of the air against the vehicle provides enough drag to slow the vehicle down.

Shuttle Imaging Radar Discovers Hidden Features in Sahara

The Shuttle Imaging Radar-A (SIR-A), flown on the second test flight of the Shuttle, November 1981, penetrated the extremely dry Selima Sand Sheet in the eastern Sahara Desert (just north of the borders of Egypt, the Sudan and Chad) to reveal previously unknown river channels, geologic structures and possible Stone Age occupation sites.

The radar signal was able to penetrate the sand dunes, drift sand and alluvium-filled valleys of the Arbain Desert to reveal bedrock and gravel subsurface features. Some of the subsurface features are nearly as broad as the Nile River Valley and could perhaps be as old as the Early Tertiary period (up to 50 million years ago).

The now-vanished major river systems which carved these large prehistoric valleys probably accomplished most of the erosional stripping which occurred in this now extraordinarily flat and hyperarid region. There is even evidence of intermittent running water during the Quaternary pluvial period (during the last million years).

Shuttle imagery taken during the second flight of the Space Shuttle last November superimposed on Landsat imagery. These photographs display the large scale penetration of windblown sand deposits that was achieved by the Shuttle Imaging radar-A experiment during Nov. 1981.

The presence of old drainage networks, originally detected in the radar images and confirmed with special post-flight ground geoarchaeological studies of the region, suggest an explanation for the location of many playas and present-day oasis in the Arbain Desert. These same oasis areas have been the center of episodic human habitation and in fact may have influenced habitation patterns within historic time. The average depth of the radar signal sand penetration, based on laboratory and field studies, varies locally from 1 to 5 meters. The penetration of dry sand by imaging radar can now provide a new tool for geoarchaeology and for the search for ground water and other resources in arid and hyperarid regions.

The Arbain desert region situated in southwestern Egypt and northern Sudan, is known to have supported human habitation during several periods from about 200,000 to 40,000 years ago with some reoccupation as

recent as 10,000 years ago. These Quaternary period occupations are believed to be coincident with the pluvial conditions which periodically changed the desert region to, at best, a savanna-like environment allowing small streams and playa lakes to exist. By about 5,000 years ago hyperaridity again set in and the region was abondoned by humans.

The sand sheet is virtually featureless, consisting of hundreds of kilometers of almost completely flat terrain composed of coarse sand and fine pebbles. This windblown sand cover overlies alluvial soils dated to about 8,500 years ago. The radar pictures show a completely different type of terrain underlying the sand sheet. The subsurface contains numerous river valleys and associated tributaries which were known previously only to the Neolithic and Paleolithic people and possibly early human ancestors who inhabited the area during its wet periods.

The results of the radar imaging experiment will be useful in interpreting the history of the various drainage basins which have developed, dried up and evolved in this region of the Middle East. At least four precursor river systems predate the present Nile River. Much of the earlier drainage patterns has been lost because of geologic evolution or weathering, but the indications from the Shuttle radar images point positively towards being able to reconstruct at least some of the prehistoric drainage systems.

As an example, some of the river drainage patterns discerned in the radar images flow opposite to the present day Nile system. These prehistoric systems could date as far back as the Tertiary Period (up to 65 million years ago). This paleogeology will be further assisted by future Shuttle radar flights now being planned.

The radar images have also revealed a series of semirectangular features that may be agricultural fields or pastoral sites, which are similar in form and scale to pre-Hispanic sunken-field groundwater-skimming agricultural features in the coastal desert regions of Peru. Because of the similarity between the Egyptian sites and the Peruvian fields, this may represent previously unrecognized pastoral or agricultural sites in southern Egypt.

Previous to these discoveries the potential for subsurface radar imaging had been discussed but very little work had actually been undertaken. Radar penetration is theoretically possible under a very limited range of conditions which are a function of the characteristics of the radar system and the local ground surface. The surface of the ground should be extremely smooth, thus allowing the radar signal to enter the ground rather than to break up and backscatter away from the radar's antenna.

The ground electrical characteristics should also be virtually transparent to the radar signal, dessicated sand being a very good example, wet clay soil being a bad example.

The angle the radar signal strikes the ground is also important as is the wavelength and the power. The radar signal is attenuated as it passes through the sand, both on the downward journey and the return upward journey. The type of underlying material, the degree of backscatter, the reflection angle and polarization are all important characteristics associated with this subsurface radar imaging.

The physics involved are not yet thoroughly defined. Based on the Shuttle radar results, laboratory studies to better define the theory and practical applications of this are underway.

The Principal Investigator for the Shuttle Imaging experiment is Dr. Charles Elachi, NASA Jet Propulsion Laboratory. Principal work for the remote sensing geoarchaeology was done by Jack McCauley, Gerald Shaber, Carol Breed, Maurice Golier, all with the U.S. Geological Survey, Flagstaff, Ariz., C. Vance Haynes, University of Arizona, Tucson, Bahay Issawi, Egyptian Geological Survey and Mining Authority, Cairo, and Charles Elachi and Ronald Blom, NASA JPL.

Infrared Astronomical Satellite: First Expendable Launch in 1983

NASA, in cooperation with The Netherlands and the United Kingdom, plans to launch the international Infrared Astronomical Satellite (IRAS) aboard a Delta 3910 launch vehicle from Vandenberg Air Force Base, Calif., no earlier than Jan. 25. The earliest opportunity for launch will occur about 6:30 p.m. PST on Jan. 25; the launch window will open for 12 minutes each day.

The primary objective of IRAS is to conduct a survey of the entire sky in the infrared region of the spectrum. Its telescope is expected to provide data on the energy budget of the universe, and on the birth and death of stars. It is hoped the IRAS all-sky survey also may discover a new class of extragalactic objects whose energy is radiated nearly entirely at infrared wavelengths.

IRAS measures 3.6 meters (12 feet) high and 2.16 m (7 ft.) in diameter, and will weigh 1,076 kilograms (2,365 pounds) at launch. The spacecraft will be placed in a 900-kilometer (560-mile) circular near-polar orbit. It will circle Earth every 103 minutes—14 orbits per

day. The orbit altitude was chosen to avoid contaminating the instruments by Earth's atmosphere at lower altitudes and to minimize false readings from proton strikes in the Van Allen radiation belts at higher altitudes.

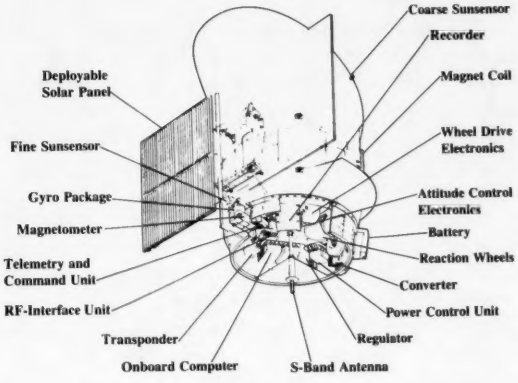


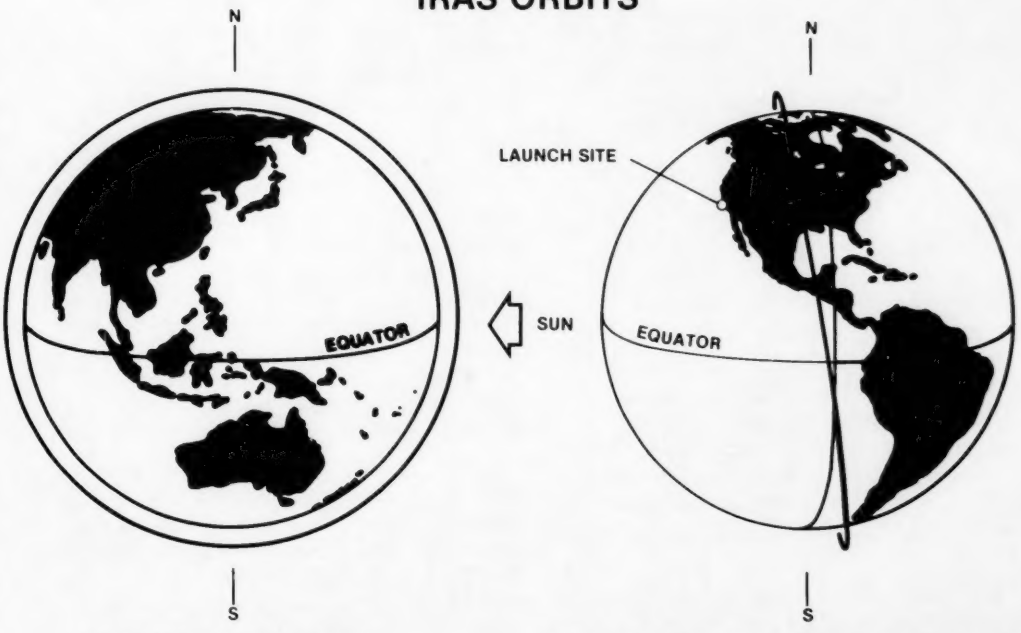
Diagram of IRAS satellite (top). Chart below shows IRAS orbits.

IRAS, unhampered by atmospheric obstruction, will search for objects that emit infrared radiation. The resulting sensitivity to the observed frequencies may be as much as 1,000 times greater than previous work from the ground, airplanes or rocket flights. The mission's primary products will include an infrared sky map and a catalog of infrared sources.

The spacecraft carries a cryogenically cooled, 60-centimeter (24-inch) Ritchey-Chretien telescope that is expected to fill a significant scientific gap in measurements of the electromagnetic spectrum between the visible region and radio waves. Infrared telescopes require a cold environment to detect signals above the thermal noise of the system. Therefore, IRAS carries a cryogenic system containing 475 liters (125 gallons) of liquid helium. The helium will maintain the infrared detector array in the focal plane at about 2 degrees Kelvin (−455 degrees F) throughout the lifetime of the mission. Mission duration is determined by the time required for the liquid helium to boil off to space.

IRAS will collect about 900 million bits of data per day. After launch and a two-week in-orbit checkout, IRAS will begin its sky survey. The United Kingdom,

IRAS ORBITS



FIRST ORBIT DECEMBER 1982 (SUN IS BEHIND EARTH)

ORBIT IN MARCH 1983 AFTER ITS SLOW PRECESSION (ROTATION) TO KEEP THE TELESCOPE'S VIEW 90° FROM THE SUN AND SUNLIGHT ON THE SOLAR PANELS

with funding through the Science and Engineering Research Council will provide tracking and data acquisition. The control center and the tracking station are located at Rutherford-Appleton Laboratory at Chilton, near Oxford, England.

Twice a day IRAS will transmit data to the antenna at Chilton, and the commands for the next period will be uplinked to the satellite. The team at Chilton will process part of the data to determine satellite condition, and to determine if the survey operations should be altered to suit any change in conditions. The full data set will then be transmitted via satellite to NASA's Jet Propulsion Laboratory for complete processing.

Two basic operations functions will be carried out during the project lifetime: (1) Gather the infrared data and generate a working survey data base and additional observation data tapes for the scientific users. (Additional observations are scientific observations of specific, interesting objects, and are separate from the all-sky survey.) This function will be performed primarily at JPL. (2) Generate the final data products for the project—the infrared sky maps and infrared source catalog—that summarize the observation of the mission. This function will be carried out at NASA's Jet Propulsion Laboratory.

The IRAS satellite consists of a spacecraft and the telescope and its detector system. The spacecraft, or bus, supplies electrical power and pointing control, and houses IRAS's telemetry and computer electronics.

The Netherlands is responsible for the design and manufacture of the spacecraft bus, and integration, testing and launch of the satellite. The Netherlands Agency for Aerospace Programs (NIVR) managed the manufacturing. The spacecraft was built by the Industrial Consortium IRAS (ICIRAS), consisting of FokkerBV and Hollandse Signaalapparaten M.V., assisted by the National Space Laboratory (NLR).

NASA is responsible for design and manufacture of the telescope, built by Ball Aerospace, Boulder, Colo., processing of the experimental data to produce the final infrared catalog by NASA's Jet Propulsion Laboratory, Pasadena, Calif. and the launch vehicle manufactured by McDonnell Douglas Astronautics Co., Huntington Beach, Calif.

The Dutch Additional Experiment was built by the Space Research laboratory of the iversity of Groningen, with the Institute for plied Physics (TPD-TNO) as subcontractor.

The Dutch Additional Experiment, consisting of three instruments in a single package are placed in the focal plane array of the telescope and include: a low-resolution spectrometer, a long-wavelength photometer and a short-wavelength-channel photometer. They are designed to complement the survey telescope and to meet a broad range of scientific objectives.

The low-resolution spectrometer is comprised of five detectors that will acquire spectra of strong infrared point sources observed by the main telescope in the wavelength range from 7.4 to 23 microns. Data from the instrument will aid in classification of infrared sources. The detector outputs are sampled and recorded continually. The data-processing system on the ground will use point-source detections from the primary-telescope data to find the exact locations of spectra in the data stream from the low-resolution spectrometer. The low-resolution spectrometer is used in combination with the main telescope.

The long-wavelength photometer employs two detectors, chopped photometry channels that allow both absolute and differential photometry of the infrared sources. The instrument is designed to map infrared sources that radiate in two wavelength bands simultaneously—from 41 to 62.5 microns, and from 84 to 114 microns. The long-wavelength photometer cannot be used while the survey telescope is operating.

The short-wavelength-channel photometer uses a single detector that scans at the survey rate, and covers the wavelength band from 4.1 to 8 microns. It is designed to obtain information on the distribution of stars in areas of high stellar density. It will provide statistical data on the number of infrared sources.

An experiment aimed at helping designers of future space power systems is attached to the second stages of the Delta launch vehicle that will carry IRAS to orbit. It is called Plasma Interaction Experiment II (PIX II) and will provide detailed information on the electrical interaction of space plasma with high-voltage spacecraft surfaces. Engineers believe a number of spacecraft irregularities or failures may have been caused by the interaction between plasma and high-voltage surfaces in the past.

PIX II is the second experiment to investigate the effects of space plasma on solar arrays, power-system conductors, insulators and other exposed spacecraft components. Engineers expect the information gained from PIX II to enable them to develop reliable, large, high-voltage (100 volts or higher) power-generation systems for future applications.

NASA's Jet Propulsion Laboratory has the responsibility for the American project management for NASA's Office of Space Science and Applications. JPL is also responsible for processing data from IRAS, with

the Science Data Analysis System. NASA's Ames Research Center, Mountain View, Calif., under JPL direction, managed the development of the telescope.

The Delta Project Office at Goddard Space Flight Center, Greenbelt, Md., provides the Delta launch vehicle, and Kennedy Space Center, Fla., is responsible for the IRAS launch at Vandenberg Air Force Base, Calif.

Tracking and Data Relay Satellite Contract Modified

After almost two years of study and negotiations, NASA and the Space Communications Co. (SPACECOM), Gaithersburg, Md., have agreed to a modification of the contract for operation of the Tracking and Data Relay Satellite System (TDRSS) which gives NASA full control and use of the in-orbit tracking system and its single ground station at White Sands, N. Mex. Under terms of the contract modification, SPACECOM, a partnership affiliated with Continental Telecom, Inc., Fairchild Industries, Inc., and the Western Union Corp., has relinquished its right to use of the Advanced Westar, the commercial telecommunications portion of TDRSS.

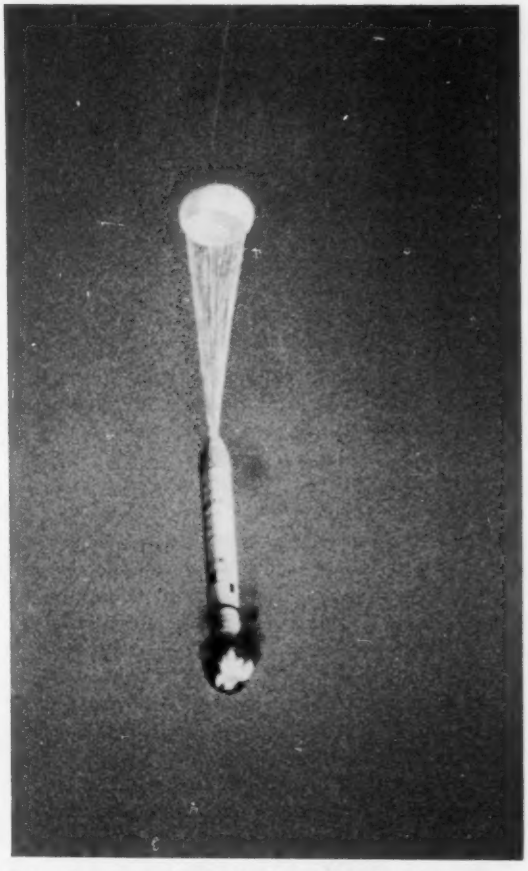
For NASA, control of the TDRSS (a national asset and a vital element of the Space Transportation System) will permit schedule and performance requirements to be based solely on NASA's needs and those of other government agency users of the system. The change eliminates the potential for conflicts with commercial communication operations. Another benefit to NASA is that it will now have greater management control over TDRSS specification and test plans and greater flexibility in making system and operation decisions.

The cost to NASA in acquiring operational control of the TDRSS for dedicated government use will be about $216 million, which will compensate SPACECOM for its Advanced Westar investment and related costs. With this moment NASA gains increased capability and flexibility in the system as well as the potential to extend the system life by several years because all of the satellites will be dedicated to NASA use.

SPACECOM will continue to own and operate the TDRSS—leasing the service to NASA— for a 10-year period beginning early next year under terms of a contract awarded in December 1976. The system reverts to NASA ownership after the 10-year period.

The contract modification will make available six satellites to provide TDRSS service—three in geosynchronous orbit (one of which is a spare) and three available as ground spares. This is expected to permit extension of the TDRSS beyond the planned 10-year operating period because additional replacement satellites have been made available. Moreover, the ground spares could be modified, if necessary, to take advantage of new technology involving different frequencies and higher data rates.

The first of three launches of the NASA-dedicated TDRSS is scheduled for February 1983 on board the first flight of the Space Shuttle Challenger. The second launch is scheduled next June, which will provide full TDRSS coverage for the first Spacelab mission in September 1983.



Return from Space—Solid rocket boosters from the fifth Shuttle mission plummet into the Atlantic Ocean after launch Nov. 11. As an added safety precaution, the parachutes remained attached to the boosters until recovery teams could detach them. The boosters for the fourth Space Shuttle mission were lost due to a systems failure with the parachutes. Photo above is the spacecraft's left (at separation from the external tank) solid rocket booster.

Contractor News

IBM, Federal Systems Div., Cape Canaveral, Fla., has been awarded a $2.4 million contract modification for additional services under an existing cost-plus-award fee contract to provide systems engineering and software development services for the Launch Processing System at Kennedy. This contract modification calls for IBM to develop techniques to aid Launch processing System users in developing applications software for a multi-flow, multi-vehicle environment and increasing launch rates. IBM currently provides the detailed design, development, validation, configuration management, and maintenance of the Launch Processing System software, which provides programming instructions to the sophisticated computer system used in the automated checkout and launch of Space Shuttle vehicles from Kennedy. This contract modification is for the period from July 1, 1982 through September 30, 1983 and brings the cumulative value of the parent contract to $88,352,204.

Wyle Laboratories, Hampton, Va., has been selected for contract negotiation by NASA's Langley Research Center to provide electronics instrument support for Langley. The cost-plus-award-fee contract will cover a period of five years and is valued at approximately $35 million. The contract began Oct. 1, 1982. Wyle Laboratories will provide instrument inspection, calibration, maintenance and application to satisfy the measurement requirements of tests conducted in Langley's test facilities. The company will also provide design, modification and maintenance work on hardware and computer programs. The work will be done at Langley and at the Wyle plant in Hampton.

General Dynamics Corp., Convair Div., San Diego, Calif., has been awarded a contract modification by NASA's Lewis Research Center, Cleveland, for five additional Atlas Centaur launch vehicles for eventual use by the U.S. Air Force. The cost-plus-incentive-fee contract modification is for $30.3 million, bringing the revised amount of the base contract to $84 million. Principal work to produce the additional launch vehicles will be performed at General Dynamics facilities in San Diego. The Atlas launch vehicle has largely been used as a first-stage booster, with a Centaur launch vehicle as the second or upper stage to deliver high-orbit payloads and undertake interplanetary missions.

From NASA's Kennedy Space Center, Fla:

David Boland, Inc., Titusville, Fla., has been awarded a $1.2 million contract for modification to the Orbiter Processing Facility where Space Shuttle orbiters are prepared for launch. The work will be done in the Orbiter Processing Facility at the Center. The Facility serves as a sophisticated hanger for orbiter spacecraft between missions; here spacecraft systems are revalidated for flight, and horizontally-processed cargoes are installed in the cargo bay. Under terms of the contract, Boland will install payload contamination controls in both Facility high bays to keep clean, filtered air blowing through the orbiter's payload bay during pre-launch processing; modify several platforms in Bay 1 to provide better access for working on the spacecraft; and install in Bay 2 a series of eight valve panels in the system used to drain left-over hypergolic propellants out of the orbiter.

Reynolds, Smith and Hills, Jacksonville, Fla., have been awarded a $1.06 million contract extension for design services in converting an Apollo program mobile launcher to a mobile launcher platform for the Space Shuttle. The fixed-price contract stipulates the design work will be completed by Aug. 31, 1983. The mobile launcher platform serves as the foundation from which the Space Shuttle is assembled, transported, and launched. The conversion of the platform will require that the tower sections, which provide a service structure from which technicians can work, be removed. Exhaust holes will have to be built to accommodate the two solid rocket boosters on the shuttle, and the systems on board the mobile launcher platform, such as power and cryogenics, will be upgraded to satisfy the demands of the Shuttle.

A $5.9 million joint venture contract has been awarded to the firms of **Briel, Rhame, Poynter & Houser** and **PRC Systems Service Company,** Cocoa Beach, Fla. The contract calls for the design of ground support equipment at launch pad 39B, which will be used to launch NASA's Space Shuttle beginning in the mid 1980s. The fixed-price contract covers the period from Nov. 22, 1982 through June 30, 1983. The provisions of the contract will be carried out at PRC's facilities at Cape Canaveral and at the Kennedy Space Center. The contract calls for the design of about half of the ground service equipment (GSE) that will be installed at Launch Pad 39B. The GSE consists of the components and equipment that regulates and distributes gases and propellants to the launch pad. Major elements of the GSE to be designed include the orbiter's fuel cell servicing system. The External Tank's gaseous hydrogen vent and the gaseous oxygen vent arm and cap will be installed as will liquid oxygen and hydrogen electrical control panels which regulate the flow of propellants to the tank. Modification of Pad 39B should be completed by Jan. 1986 and will supplement Launch Pad 39A, now being used for Space Shuttle launches.

Expendable Launches for 1983

Name	Launch Date	Vehicle	Range	Mission Remarks
IRAS	January 25	Delta	WSMC	Infrared astronomy. NASA scientific.
Intelsat V-F	March 10	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
RCA-F	March 31	Delta	ESMC	RCA communications. Reimbursable.
NOAA-E	March	Atlas-F	WSMC	NOAA weather and SARSAT. Reimbursable.
NAVY-21	2d quarter	Scout	WSMC	DOD transit. Reimbursable. Call up.
GOES-F	April 28	Delta	ESMC	NOAA weather. Reimbursable.
Galaxy-A	June 9	Delta	ESMC	Hughes Communications, Inc. Reimbursable.
HILAT	June	Scout	WSMC	Air Force research and development. Reimbursable.
Telstar-3A	July 28	Delta	ESMC	AT & T communications. Reimbursable.
San Marco D/L	July	Scout	SMR	International cooperative/Italy.
RCA-G	August 25	Delta	ESMC	RCA communications. Reimbursable.
AF-1	August	Scout	WFC	Air Force development program. Reimbursable.
NOAA-D	August	Atlas-F	WSMC	NOAA weather. Reimbursable.
Galaxy-B	September 22	Delta	ESMC	Hughes Communications, Inc. Reimbursable.
NATO-IIID	October 27	Delta	ESMC	NATO communications. Reimbursable.
NAVY-22	4th quarter	Scout	WSMC	DOD transit. Reimbursable. Call up.
Intelsat VA-A	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

Space Shuttle Launches for 1983

Orbiter	Launch Date	Launch Number	Launch Site	Payload
Challenger (OV-099)	February	6	KSC	TDRS-A
Challenger (OV-099)	April 20	7	KSC	OSTA 2: SPAS-01 Telesat-F: Palapa B-1
Challenger (OV-099)	July 4	8	KSC	INSAT 1-B: TDRS-B
Columbia (OV-102)	September 30	9	KSC	Spacelab 1
Challenger (OV-099)	December 14	10	KSC	DOD 84-1

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patient No.	Installation
Dean W. Sheibley, Lorra L. Rieker and Li-Chen Hsu, NASA/LeRC	Polyvinyl alcohol cross-linked with two aldehydes	4,357,402	LeRC
Glenn M. Ecord and Calvin Schomburg, NASA/JSC	Method of repairing surface damage to porous refractory substrates	4,358,480	JSC
Glenn M. Ecord and Calvin Schomburg, NASA/JSC	Densification of porous refractory substrates	4,358,486	JSC
Percy H. Rhodes, NASA/MSFC	Static continuous electrophoresis device	4,358,358	MSFC
Larry E. Morgan, NASA/KSC	Serial data correlator/code translator	4,358,846	KSC
Jan Harper-Tervet, Fred W. Tervet and Marshall F. Humphrey, Caltech/JPL	Mixed polyvalent-monovalent metal coating for carbon-graphite fibers	4,359,503	NRO/JPL
Charles W. Galloway, NASA/JSC	Gas-to-hydraulic	4,360,325	JSC
John C. Evans, Jr., NASA/LeRC	Heat transparent high intensity high efficiency solar cell	4,360,701	LeRC

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

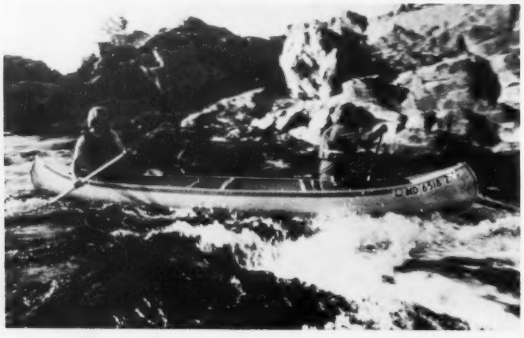
Advanced Welding Tool

A welder, orginally developed for use in any environment, including the weightlessness of space, now provides a new way of mending plastics. Originally developed by NASA's Langley Research Center, the welder was designed specifically for joining parts made of plastic or composite materials often difficult to join by conventional methods. Adhesive bonding is not reliable in a vacuum, riveting techniques often deform the plastic, and mechanical fasteners require hole preparation and special hardware.

The Langley developers designed a tool which used induction or magnetic heating which causes little or no deformation and can be used with almost any type of thermoplastic material. An inductor coil transfers magnetic flux through the plastic to a metal screen, which is sandwiched between the sheets of plastic to be joined. When the welder is energized, the alternating current produces inductive heating on the screen and causes the adjacent plastic to melt and flow into the mesh. This creates a bond of the total surface area,

where conventional hot gas welding produces only a peripheral bond.

The commercial spinoff welder, the Inductron Toroid Welder* produced by Inductron Corp., Grafton, Va., is a self-contained portable welding gun with a switch on the handle to regulate the temperature of the plastic-melting screen. Capable of joining dissimilar materials, thermoplastic or non-thermoplastic, the welder has a broad range of applications in the automobile, appliance, aerospace and construction industries. Shown here is one application: canoe repair.



*NASA does not endorse commercial products as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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